Tech Bytes

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Contents

Vijaipur Unit

Repair Methodology of tube leakage in Reformed Gas (RG) Boiler in Ammonia- I plant at NFL, Vijaipur- A case study

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Introduction:

Reformed Gas (RG) Boiler in Ammonia Plant of Line-1 is installed at the downstream of primary & secondary reformer for generating 235 MTPH of 100 ATA steam by using waste heat of reformed gas. The reformed gas enters the tube side of the RG Boiler and heat of reformed Gas is used to generate steam.

The above said RG Boiler is in service since 2015 and was supplied by M/s L&T. This L&T make RG Boiler was installed as replacement of original installed BORSIG make RG Boiler (Installed in 1987).

RG boiler is a horizontal type, two compartment boiler. The gas side of this boiler is high alumina refractory lined. The tube sheet is also refractory lined. Gas entry and exit side of tube sheet is protected with high nickel ferrules to protect tube sheet against metal dusting.

The reformed gas enters in first compartment at 959 ^{0}C and leaves at 665 ^{0}C, while in second compartment, the gas enters at 665 ^{0}C and leaves at 347 ^{0}C. The waste heat is utilized to generate saturated steam at pressure of 117 kg/cm^2 (a) leading to reduction of reformed gas temperature at outlet of RG Boiler.

The first compartment has 494 tube size: 58 OD x 6.6mm Thickness MOC: SA213 Gr T11 and second compartment have 1020 tube size: 34 OD x 4.5 mm Thickness MOC: SA213 Gr T11.

The material of construction of ferrules used at inlet of first compartment (temp 959 ^{0}C) is SB167 UNSNO6601 and the material of construction of ferrule use at outlet of first compartment & at inlet of second compartment is (temp 665 ^{0}C) SB167 UNSNO6693.

Observation:

During start- up of plant, post tripping on 19.12.2021 leakage in RG Boiler was suspected & following observations were recorded:

- The inlet gas temp of RG Boiler was not increasing with feed in of air in secondary reformer.

- Mid-Section temp was not reaching normal temperature.
- BFW consumption increased with respect to steam generation.

Plant was kept in-line. On 2nd April, the outlet temp of RG Boiler suddenly reduced to 300 ^{0}C, and it was not possible to run the plant. The heavy leakage in RG Boiler was thus confirmed.

Hence it was decided to take shutdown to attend the leakage. The plant was stopped on 02.04.2022 and job for attending tube leakage was taken up after draining and cooling down.

Diagnosis & Action Taken:

After opening of manholes thorough inspection of RG Boiler was done. The inlet and outlet portion of RG Boiler were found intact. In the mid-section of RG boiler, some of the ferrules were found outside the tubes and refractory in that area was also found substantially damaged.

To check the leakage, shell side of RG Boiler was filled with water. No leakage was observed in the 1st compartment. In the second compartment, leakage was found from two tubes. Out of two tubes, one tube had the major leakage and other tube had minor leakage.

Hence it was decided to plug the leaky tube. During further inspection it was found that the tube having major leakage, has been detached from the tube sheet. Erosion of tube sheet in the vicinity of respective tube was also found.

The shell side design pressure of RG Boiler is 130.5 Kg/cm2, with thickness of the tube sheet as 28 mm only. Being a special flexible tube sheet design, plugging of tube was a challenging job. All tubes are strength welded with tube sheet. OEM of equipment was also contacted and after lot of brain storming the plugging procedure was finalized for major leaky tube. For major leakage, the plugging was done with stray rod, sleeve and plug assembly.

For minor leakage, the tube was plugged by using plug of P11 material. After plugging of tubes, hydro testing of RG Boiler was done. Two more tube leakage was again detected and same were plugged.

After plugging of all 4 tubes, final hydro test at hydro test pressure was done and found satisfactory. The procedure for tube plugging is as given below:

1. Tube having minor leakage

    - After identifying the tube having minor leakage, the tube inside area was cleaned. A suitable size of plug of SA739 Gr B11 was placed in leaky tube. Preheating up to 150 ^{0}C was done and welding was done with 80S filler wire.

2. Tube plugging with Stray rod and sleeve

    - The tube was cut at 6-8 mm from back side (shell side) face of inlet tube sheet where the tube is detached from tube sheet. This cutting was done with special tool by machining the tube sheet around the periphery of the leaky tube using especially designed machining tool area.
    - Grind off residual tube and tube to tube sheet weld through tube sheet thickness so that this hole for tube is drilled to make the round size (throughout the tubes sheet thickness)
    - Sleeve was inserted within this finished tube sheet hole. The sleeve OD was machined so as to maintain the clearance between final hole dia. Then the mechanical expansion of the sleeve throughout the length of the tube sheet was performed and the sleeve was welded at the face of tube sheet.
    - For plugging the tube, one plug was inserted from inlet end and stay rod from outlet end within tapped hole of plug 1 was fitted.
    - Second plug was inserted from outlet end Second plug was tightened so that stay rod remained in tension and plug 1 can be pulled against the tube sheet.
    - Welding between inlet end plug and sleeve and between plug and tube at the outlet end was carried out. Also, welding between stay rod and plug at the outlet end was done. Afterwards complete welding and DPT was carried out.

Following inspections were carried out:

- DPT of the tube sheet in the middle compartment and outlet compartment in the exposed zone was carried out to the extent possible.
- Borescope examination of some of the tubes was also carried out with available in-house facility.
- Hand holes of the RG Boiler were opened to access the shell side condition.

<u>Conclusion & Recommendations:</u>

The subject tube failure in this RG Boiler of Ammonia -I plant is a typical type of failure and is not expected in a short span of seven years of operation. The most prominent probable reasons of the failure are:

- Defect in tube metallurgy and/or Weld defects as the leakage has been observed just adjacent to the tube sheet and this being strength welded tubes, weld defect can't be ruled out.
- To find root cause of the leakage, the matter has been taken up with OEM of equipment and the same is under study at their end.

In the next shut-down, it has been planned to carry out exhaustive inspection of the RG Boiler and shall include the followings:

- Removal of complete refractory and the ferrules.
- DPT of the tube sheets
- Eddy current testing and Borescope examination of all the tubes.
- Other analysis as desired by OEM based upon their analysis.

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Nangal Unit

Reducing water footprints at NFL Nangal: A step towards building a better tomorrow!

by Anupam Chhabra, M (TS)

Introduction:

Water is one of the main natural resources that support life on our planet. According to the United Nations (UN), the planet has about 1.4 billion km^3 water which is finite and is dwindling due to growing population, ongoing development, effects of global warming etc.

Visualizing the present & future scenario of availability of water, water conservation is of utmost importance.

Water is also one of the major inputs to NFL Nangal Unit and it is being lifted from river Sutlej. Raw Water after filtration is used for various purposes like:

- ✓ Cooling Water make up
- ✓ Once through cooling water
- ✓ DMW / BFW in boiler to raise steam
- ✓ Drinking water
- ✓ Fire water
- ✓ Filtered water for de-ashing purpose in coal-fired boiler.

Observations:

Total average intake of raw water inside the factory is to the tune of ~3000 m^3/hr with consumption of about 800 m^3/hr of water in plant area whereas the remaining i.e. ~2200 m^3/hr of water is discharged back into the river through main drain.

In Urea plant, around 400 m^3/hr of once through raw water is used for cooling purpose in E-2/N (Vacuum condenser) and is drained locally to main drain. As this water was being drained with no effluent and with minor temperature rise of 3-4^0C, possibility of utilizing this outgoing raw water as make-up in Cooling Towers and in BFW section was explored. Further the system pressure of E-2/N is lower than the raw water pressure and therefore outlet water from E-2/N could be easily re-used to avoid risk of contamination.

<u>Action taken:</u>

The outlet water of E2/N was diverted from main drain towards Cooling Towers and Clariflocculator in BFW plant for make-up. Around 150 to 250 m^3/hr of E2/N outlet water was diverted for use as make up water in cooling towers and in BFW plant.

The total expenditure for implementation of above said scheme was only for layout of lines for interconnection to make up cooling water header and to raw water header of BFW plant along with isolation valves etc., which was done with mere expenditure of ~Rs 10 lakhs.

Benefits:

Re-use of E-2/N outlet water has reduced the equivalent amount of fresh water intake from BBMB and has also reduced once through water outlet flow in main sewer which is an indirect benefit.

Considering average re-use of 200 m^3/hr of raw water, saving on account of reduced water intake is to the tune of ~Rs 75 Lakhs per annum.

In addition to above, following other steps have been also been taken by NFL Nangal to reduce water footprints:

1. About 5 m^3/hr of coal mill cooling water (Raw water) was diverted from main drain to ash water sump for make-up thereby reducing equivalent amount of fresh water intake.

2. About 10 m^3/hr of OWS water was diverted from ETP plant to Ash water sump for make-up thereby reducing load on ETP and also reducing fresh water make-up.

3. Apart from above mentioned steps, Nangal Unit encourages its employees to:
    - Turn off the tap after use.
    - Use water cans in place of hoses for watering the gardens
    - Water the plants only during evening / early morning
    - Wash full loads of laundry
    - Wash the vehicles in the garden using buckets instead of hoses

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Nangal Unit

Implementation of Modification (with special techniques) in Ammonia Convertor Shell Top cover- A for relocation of Thermocouples- case study

by Umesh Kumar, CM (Mech.)

Introduction:

N.F.L Naya Nangal unit was commissioned in 1978 with an installed capacity of 3.30 LMT and revamped in 2001 to enhance the annual installed capacity from 3.30 LMT to 4.785LMT per year. In ammonia plant, Ammonia feed change over project was completed in 2013 with Natural gas as feed and with daily production capacity of 950 MT of ammonia. The ammonia plant has single ammonia convertor installed with S-200 series basket of M/s HTAS design. The convertor basket was installed in 1995 and catalyst was replaced in 2006.

During month of June-2021, loop pressure of Ammonia Syn gas section had increased and conversion rate was drastically reduced. This resulted in load limitation in Ammonia Plant. After due deliberation and study of process parameters, it was decided to replace the convertor basket and catalyst with new identical basket which was earlier brought from F.C.I Sindri .

Before installation of new convertor basket its dimensions were checked and compared with already installed one. During comparison of dimensions, it was observed that the PCD (Pitch Circle Diameter) of thermocouple holes (2 Nos.) of new basket is 830mm and old basket is 750mm. So before installation of new basket, convertor top cover thermocouple hole has to be re-oriented to suit with new basket assembly. It was decided to make two numbers of additional holes at PCD of 830 mm at 90° opposite.

Observations:

Without this modification, replacement of convertor basket was not possible. As criticality and accuracy of this modification were of prime importance and job has to be completed in strict minimum time frame of 6 days, so, it was planned to execute this job in NFL Nangal mechanical workshop with available resources and technical know-how.

Problems expected to be faced:

Brief description of the problems expected to be faced during drilling of thermocouple holes.

i. Shifting of convertor top cover (21 tonne) from convertor site to mechanical workshop.
ii. Shifting of top cover inside the mechanical workshop.
iii. Unloading of top cover.
iv. Shifting of top cover to drilling machine drill bed.
v. Drilling of hole in single drill position.
vi. Large thickness of cover plate 600 mm.
vii. Drill hole has stepped diameter of 34 mm, 23 mm and 30 mm.

Preliminary planning of job:

Preliminary planning, study and rehearsal were carried out to address the above mentioned problems before job start.

i. The shifting of top cover with a total weight of 21 ton was a major problem. So, it was decided to lift the top cover with 120 tonne KATO crane and shift it to mechanical workshop on 30 tonne trailer (1.5 km from convertor site to mechanical workshop).

ii. As the entrance of mechanical workshop is fixed, so trailer movement inside workshop was ensured by actual movement of trailer inside workshop well in advance.

iii. Inside workshop overhead crane of higher capacity more than 21 tonne are not available in the workshop. So it was decided to unload the top cover inside workshop with the help of tyre mounted 120 tonne KATO crane. So KATO crane was moved inside workshop and actual positioning was checked with boom angle, movement of boom etc to ensure the safe unloading of heavy weight top cover. Crane loading capacity was checked at 25° angle with 25 tonne load.

iv. As due to various building construction constraint inside workshop the top cover could not be shifted directly to position at drilling machine bed with the help of KATO crane itself. So, to solve this shifting problem it was decided to lay a rail track from unloading point to drill machine bed. A shifting trailer trolley was fabricated on which top cover was to be shifted in advance.

v. As blind drilling of 600 mm thick was to be carried out so a dummy plate was drilled to ensure the capacity and accuracy of the machine before doing the job.

vi. After complete planning and rehearsal carried out to ensure hurdle free execution of job, execution of job was started.

Diagnosis & Action taken:

Sequence of job carried out:

i. After unbolting of convertor top cover, cover was lifted with the help of 120 tonne crane and same was shifted to mechanical workshop on 30tonne trailer.

ii. 120 tonne KATO crane positioned in side mechanical workshop and top cover unloaded on fabricated roller trolley. The trolley was shifted to drill machine bed with pulling arrangement (chain block) at proper place and trolley was fixed by locking its roller. For leveling of top cover four 50 tonne hydraulic jacks were used. Leveling straight edge and sprit level were used to level the cover top surface.

iii. After proper leveling of the job, mechanical support was placed under the cover plate and hydraulic jack was released and job piece was firmly held in position.

iv. Marking of hole was done according to dimensions.

v. Drilling job was completed in five steps:
   a. Initially 22 mm drilling throughout the thickness of 600 mm was done.
   b. In second drilling process 23mm drill was done throughout the 600 mm.
   c. In third drilling process, 32 mm drilling up to 75 mm from top was done
   d. In fourth drilling process, final size of 34 mm drill was done up to 75 mm fromtop.
   e. In 5th step of drilling, reverse drilling process was adopted to avoid cover plate
   f. As for second thermocouple hole drilling, No proper approach of drill machine was available. So for repositioning of job, top cover was again shifted back to unloading point again and job was lifted with KATO crane and orientation was changed for proper approach of drilling machine.

   All five steps of drilling processes were also done for second hole drilling. The total six days time period was taken to complete this modification job in top cover of convertor.

Conclusion/Recommendations:

The tap drilling job in limited time with in-house resources was a challenging job. NFL Nangal unit workshop team, with meticulous planning, rehearsals for the job execution and out of the box solution, was able to execute the job successfully within limited time of 6-days. Further due to this, lot of time, quantum of jobs and approx. 12-15 lacs were saved.

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Panipat Unit

Titanium lined Urea Synthesis Reactor Leakage: A Case study

by A.P. Verma, SM (Mech.)
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Introduction:

Urea synthesis reactor UDC-101 was procured from M/s Kobe Steel Japan and was installed in May-95. Urea reactor is a multilayered carbon steel vessel with Titanium liner. The carbon steel shell is of 147 mm thickness comprising of 10 layers of 14.7 mm CS plate. The top and bottom are hemispherical dish ends having 6 petals each. The entire vessel is lined with titanium having a thickness of 6, 5, 4 and 3 mm at different segment of reactor. The segmental circumferential and longitudinal weld joint of liner is further protected using pad of titanium with a thickness as per liner thickness of that segment and width of 80 mm for circumferential pad plate and 50 mm for longitudinal pad plate. The carbon steel shell is only for pressure retainment.

In case of any internal liner failure, it will result in highly corrosive carbamate solution coming in contact with the carbon steel shell behind the liner, which will corrode the CS shell and would result in lethal effects. Hence, weep holes are provided to detect the leakage from the welding joint at earlier stage. Behind the welding joint of the liner pad the weep tubes are connected. There are total of 88 weep holes are provided for detecting the leakages. All the weep holes are connected to back of titanium liner are interconnected. There are total 6 segments of cylindrical portion of reactor, each having 3 rows of weep holes with 4 weep holes in each row. There are 8 nos. of weep holes in top dome and 7 nos. of weep holes in bottom dome of urea reactor. All weep holes are provided with conductivity probe.

Observations:

In normal, during every Shutdown Titanium Lining of Reactor has to be inspected to detect any defects like pinholes, porosities, cracks etc. and repair the same to prevent any unscheduled breakdown of the plant. During previous inspection it was observed that the thickness of pad plate of bottom portion of urea reactor have been reduced significantly. Thickness was reduced to 2.5 mm against the design value of 6 mm and pad plate replacement of bottom dome by reputed third party was done in Nov.'21. After running the plant for almost 40 days, again alarm of leak detection was appeared at weep-hole points P-16W, P-20W, P-21W and P-21S on 26.01.2022. Urea reactor kept under observation.

On 01.02.2022, Ammonia vapour observed from P-21 (all 4 points), P-20 (3 points) and P-19 (20points), immediately P-22 (6 points) and P-23 checked for any solution and vapour but all were OK. To remove any solution/ solid deposit at back side of liner, Steam at 0.8 kg/cm2 was provided at P-21S. After provision of steam now drop wise solution is coming from weep hole P-22E. Even after cut off the steam carbamate solution still coming outside from this point only. Plant stopped for repair job.

Diagnosis & Action taken:

Leak detection

After Buffing of the weld joints of all segments, pneumatic test was done by applying the pressure of 1500mmwc at points 22 SE, 21W and 21N and also by changing the air inlet points. After soaking time, Leak check was done with the soap solution and no leakage was observed.

DP test was done up to 3C from bottom dome, in which total of 19 point observed. Out of which, 12 were observed in bottom dome. These points were checked by third party engineer and found superficial. Other points also checked by grinding and DP test and found superficial.

After DP test the complete system was purged with nitrogen and Ammonia was charged to carry out the Ammonia leak test. Ammonia leak test was done by applying the paste of barium sulphate, Phenolphthalein and demineralized water on the weld joints. No defects were observed. After the test complete system was purged with nitrogen and reactor was handed over for maintenance. Thickness of the Reactor was checked.

Based on thickness report of liner and pad plates and pattern of leakage through liner it was decided to replace the pad plate of 1L, 2C, 2L and 3C. For this job the contract was awarded to another third party specialized in such jobs for completion of the job in minimum possible time at NFL Panipat site itself.

Repair/Maintenance jobs carried for replacement of the Pad plates:

Replacement job of the 1st and 2nd pad plates was started by the third party. Liner pad plates from 1st and 2nd segment (vertical seam 1L and 2L, Circumferential seam 2C and 3C) were removed by grinding. 2 no. of vent hole found on 2C & 3C and 1 no. of hole found on 1L & 2L. Vent holes (on batten strip) found pad plates it was observed that these holes are connected to weep hole. Air pressure of 2 kg/cm2 was given to the vent holes from inside the reactor and all weep holes are checked from outside. The flushing job of the Welding fillet joints was done.

After flushing, grinding thickness mapping was done for 3C, 2L, 2C and 1L pad plate. At some point the liner thickness adjacent to circumferential joints and longitudinal joints found in the range of 1.8 mm to 2.10 mm. Welding of liner plate below thickness of 2 mm is very critical, as there is possibility of burn out and formation of oxide.

Based on thickness mapping and in consultation with the third party, arrangement for 3C, 2L, 2C and 1L pad plate was fabricated and installed as per following arrangement.

In this arrangement 3C circumferential joint was covered with 5 mm thick pad plate of 150 mm and 100 mm width. Both these plate joint with stitch weld and this stitch weld was covered with 50 mm width of pad plate with thickness of 5mm. Fitment of the pad plates on 3C was started and then the 2C was started, after completion of the 3C &2C, 1L & 2L pad plates were fitted. After the fitting job completed, the root welding of the all plates has been done with filler wire KS-50 1.6mm. After root welding, Helium test was conducted.

- Helium test arrangement was done by weld seam bagging by polythene sheets. Helium was filled and pressured up to 1500 mmwc and pressure gauges were installed at weep hole 4N, 10E, 17S and 20W to monitor the pressure. Leak test was done by puncturing the sheet and inserting the analyzer in it. Sensitivity of the sensor in all segments was found 5X10-08 Pa m3/sec and was found OK.

- After Helium test, DP test was conducted and found OK. After Helium test and DPT of root welding, final welding of the bottom dome was done with filler wire KS-50 2.0 mm. After complete welding DP test conducted for new welding joint between 1C to 3C was carried out. In DP test 3 no of points were found. All these three point were checked by grinding and found superficial in nature. Based on thickness mapping it was decided to cover the liner thickness zone of 2 mm. Three no. of patch (2 nos. of 100x300 mm and 1 no. of 150x200 mm) were welded near 2C and 2L as thickness of liner found around 2mm in this area. After completion of patch welding, DPT was done and no defects were observed.

- After welding and DP test, hydraulic test was carried out. At the pressure of 230 kg/cm2 water seepage observed from 21S and 21W after some time 21N weep hole also found wet, all other weep holes point are dry.

- Rector was depressurized for DP test, For DP test buffing of liner plate from 1C to 1mt length above 1C and 1meter down to 2C and all welding joint up to 4C was done. In DP test total of 8 no points were observed. All these points were grinded and welded. On DPT no defects were observed.

- After repair of points observed in DP test, hydraulic test was carried out. At the pressure of 150 kg/cm2, water droplet coming from weep holes P-13 to P-

21. Hydraulic test pressure increased to 240 kg/cm2 and the leakage was monitored. At the span of 7 hrs. in 15 min intervals the leakage of 0.62 ltrs to 1.65 ltrs was observed. Again the reactor was taken under maintenance.

Repair /Maintenance and inspection

It was decided to physically inspect (for air bubble test) all welding joints from Jhoola at the time of draining, So controlled draining done through EMV 102 (NRV was dropped for draining) and physical inspection started. Air was given from outside at 2200mmwc from weep hole P-6, P-7,P- 8 and P-9 and change respectively with water level. No bubble observed in this test (may be due to chocking between liner and shell). During physical inspection water seepage was observed at the joint of 2C and old butt weld of liner plate. This seepage was due to welding crack in weld joint. Now hardness was checked at this point and found in the range of 240-254BHN. It was suspected that this crack was due excessive hardness of weld pool. This point was repaired and patch 70x40mm and cover strip 60x30mm was provided. Now hardness of all other weld joints were also checked and fount to be in normal range of 145-180BHN.

After repair and DP test, decontamination of reactor done and rector was boxed for hydraulic test. Hydraulic test was carried out at 240 kg/cm2 and found OK

Plant startup, monitoring and leakage

The plant activities were started after hydraulic test on 25th Feb'2022. Reactor feed in was carried out and the prilling achieved. Thorough inspection of the weep holes was carried for 2 days and then sensing probes were installed. No alarms or colour change in bubblers has been observed. Both Licenser and OES were contacted during reactor leakage for the possible causes and solutions.

Recommendation of OES

OES was also contacted for their valuable suggestion regarding problems and intensive repair work in urea reactor, OES stated that "In case of single lining vessel, weld repair will have a risk (burn through titanium plate) if titanium thickness where to be welded is less than 2.00 mm. Furthermore, weldability may be reduced by hydrogen absorption during long term operation" OES recommended not to perform weld repair and/or welding of additional pad plated on corroded lining.

Recommendations of Licenser:

- Titanium is relatively weak against erosion. Therefore, especially erosion-corrosion happens at the bottom where liquid and gas mixture makes turbulent flow.

- Repair location would be easily corroded due to blowhole, crack, lack of weld penetration, and corrosion pit. it is not practical to take preventive measures to avoid leakage once the existing lining deteriorates. Therefore, it is essentially required for experienced persons to attend the repairing activities
- To identify the leaked location proceed of helium leak test; and/or dye penetration testing

Toyo recommended procurement of new reactor with DP-28W lining

<u>Conclusion and recommendations:</u>

Urea synthesis reactor, UDC-101 was procured from M/s Kobe Steel Japan and was installed at Urea plant in year 1995. After approx. 27 year of continuous service present reactor has outlived its life and now it is giving frequent problems. Due to following reasons the reliability of present Urea reactor is highly reduced:

- Repeated welding repair at bottom portion of Urea reactor.
- Appreciable reduction in thickness of Titanium liner plate up to 3C.
- Decrease in overall liner thickness of urea reactor results in difficulty in welding repair of titanium lining because deep pin hole/crack in thin liner needs patch plate welding, which further deteriorates the properties of parent metal causes more prone to leakage.

Following is therefore recommended:

Monitoring of weep holes for clearance of all connected path should be carried out on weekly basis.

- Repeated overlaying of Titanium seam should be avoided.
- Any suspected leaky point should be repaired by providing patch of similar liner material so to avoid HAZ area for any further heat input.
- Always keep the weld metal hardness less than 200 BHN to avoid stress corrosion cracking

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Bathinda Unit

Malfunction of the Auto Recirculation Valve (ARV) of BFW Pump (AGA-701B) in Ammonia plant.

by Vicky Singla, M (Mech.),
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Introduction:

Boiler Feed Water Pumps (AGA-701A/B) in Ammonia plant are multistage horizontal pump driven by steam turbine which operates with steam of 40 kg/cm2. There are two main BFW pumps, one running and one *stand*-by. Besides, 02 Nos. motor driven BFW pumps (GA-704 & New) pumps of lower capacity are also there which are taken in service during plant start-up. Also, it takes auto start whenever the BFW header pressure drops to 112 kg/cm2. All the above mentioned 03 Nos. pumps are installed with individual auto-recirculation valves (ARV) to take care of the minimum flow through the pumps. Each ARV is having an isolation valves at the d/s side. Normally, these isolation valves are kept open so that in case of any problem in one of the main pumps, AGA704 takes auto start to maintain the BFW requirement in the minimum time to avoid plant tripping.

Observations:

The plant was running normal at full load on 02.11.2021. The BFW Pump AGA-701B was in line with all operating parameters in normal range (Pressure: 128 Kg/cm2, Temperature 136 ^{0}C and Flow around 298 M3/hr). Suddenly, the lube oil pressure of the pump dropped from 1.8 kg/cm2 (g) to 0.5 kg/cm2 (g) which resulted in tripping of pump on low LO pressure. Although its Auxiliary Oil Pump (AOP) took auto-start at 0.8kg/cm2 (g) even then oil pressure touched trip value of 0.5kg/cm2 for fraction of time and tripped the BFW pump.

After tripping of AGA-701B Pump, the BFW pump AGA704 took auto start on low BFW header pressure (112 Kg/cm2g) to maintain BFW pressure in the header. At the same time it was noticed that Pump GA-701B started rotating in reverse direction because of BFW flow through it due to malfunction of its ARV and discharge flow of AGA704 was diverted to deaerator through AGA 701 B pump because of its ARV passing.

Sequence of Events:

1. Ammonia Plant was running normal on 02.11.2021 at 110% Ammonia Plant Load.
2. Turbine driven BFW pump AGA 701 B tripped due to low lube oil. Its AOP took start on auto.
3. Motor driven BFW pump (AGA 704) took auto start at low BFW header Pressure.
4. 2nd motor driven pump (New BFW Pump) was also started immediately.
5. The load on both the motor driven pumps was increased through their respective HIC signals.
6. New BFW motor driven pump tripped due to overload. BFW header pressure/flow could not be maintained.
7. Subsequently IS-1 of Ammonia Plant actuated owing to low level of RG boiler subsequent to tripping of turbine driven BFW pump.
8. Due to tripping of BFW pumps HRSG also tripped at low steam drum level.
9. Due to complete tripping of Ammonia plant Urea Plant also tripped.

Diagnosis & Action taken:

Following actions were taken during maintenance of pump.

1. Main Oil Pump (MOP) of AGA-701B found seized which resulted in drop of oil pressure. The MOP was replaced with spare MOP assembly.
2. Time lag of auto start of AOP pump at pressure of 0.8kg/cm2 did not avert the oil pressure from falling further to touch the trip oil pressure value of 0.5kg/cm2.
3. As ARV of AGA701B was passing, its inspection & rectification was done during opportunity shutdown.
4.
5. All three no of PTs were checked and found OK.
6. MLO pump of AGA 701 B was replaced in October-2021.
7. ARV of AGA 701 B was overhauled in the year 2017.

Conclusions & Recommendations:

From the above given facts, following can be concluded:

1. Henceforth, the ARV & Main oil Pump shall be checked for operation at different intervals of time & at the available opportunity and its preventive maintenance will be done to avoid sudden malfunctioning as the cascading effect of ARV malfunction can result in shutdown of complete plant.

2. At Bathinda Unit, it has been decided to procure MOP on OEM proprietary basis only and accordingly action for procurement of new MOP from the OEM M/s Ebara has been initiated thereby ensuring the reliable operation of the lube oil system of BFW pump. Regarding reliability of ARV, it has been planned to carry out reconditioning of the same during ATA or available opportunity at an interval of 2-3 years.

3. AOP system should be adequate to take care that the oil pressure drop due to sudden failure of MOP does not touch the trip limit to avoid machine tripping. In this regard, a proposal for review of AOP auto-start pressure setting is under process within Unit & its outcome will be taken up with the OEM for finalization.

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